A[1]

Heavy oils and bitumens can be upgraded using a range of rapid processes including thermal (e.g., US 4,490,243; US 4,294,686; US 4,161,442), hydrocracking (US 4,252,634) visbreaking (US 4,427,539; US 4,569,753; US 5,413,702) or catalytic cracking (US 5,723,040; US 5,662,868; US 5,296,131; US 4,985,136; US 4,772,378; US 4,668,378, US 4,578,183) procedures. Several of these processes, such as visbreaking or catalytic cracking, utilize either inert or catalytic particulate contact materials within upflow or downflow reactors. Catalytic contact materials are for the most part zeolite based (see for example US 5,723,040; US 5,662,868; US 5,296,131; US 4,985,136; US 4,772,378; US 4,668,378, US 4,578,183; US 4,435,272; US 4,263,128), while visbreaking typically utilizes inert contact material (e.g., US 4,427,539; US 4,569,753), carbonaceous solids (e.g., US 5,413,702), or inert kaolin solids (e.g., US 4,569,753).

At page 13, please replace the paragraph at lines 24-29 with the following:

A[2]

Furthermore, the liquid products of the present invention may be characterised using Simulated Distillation (SimDist) analysis, as is commonly known in the art, for example but not limited to ASTM D 5307-97 or HT 750 (NCUT). SimDist analysis, indicates that liquid products obtained following processing of heavy oil or bitumen can be characterized by any one of, or a combination of, the following properties (see Examples 1, 2 and 5):

At pages 14-15, please replace the paragraph, beginning at page 14, line 22, and continuing to page 15, line 23 with the following:

A[3]

The vacuum gas oil (VGO) fraction produced as a distilled fraction obtained from the liquid product of rapid thermal processing as described herein, may be used as a feedstock for catalytic cracking in order to covert the heavy compounds of the VGO to a range of lighter weight compounds for example, gases (C_4 and lighter), gasoline, light cracked oil, and heavy gas oil. The quality and characteristics of the VGO fraction may be analysed using standard methods known in the art, for example Microactivity testing (MAT) testing, K-factor and analine point analysis. Analine point analysis determines the minimum

temperature for complete miscibility of equal volumes of analine and the sample under test. Determination of analine point for petroleum products and hydrocarbon solvents is typically carried out using ASTM Method D611. A product characterized with a high analine point is low in aromatics, naphthenes, and high in paraffins (higher molecular weight components). VGOs of the prior art, are characterized as having low analine points and therefore have poor cracking characteristics are undesired as feedstocks for catalytic cracking. Any increase in analine point over prior art feedstocks is beneficial, and it is desired within the art to have a VGO characterized with a high analine point. Typically, analine points correlate well with cracking characteristics of a feed, and the calculated analine points obtained from MAT. However, the observed analine points for the VGOs produced according to the procedure described herein do not conform with this expectation. The estimated analine points for several feedstocks is higher than that as measured (see example 6; Tables 16 and 17). This indicates that the VGOs produced using the method of the present invention are unique compared to prior art VGOs. Furthermore, VGOs of the present invention are characterized by having a unique hydrocarbon profile comprising about 38% mono-aromatics plus thiophene aromatics. These types of molecules have a plurality of side chains available for cracking, and provide higher levels of conversion, than compounds with reduced levels of mono-aromatics and thiophene aromatic compounds, typical of the prior art. Without wishing to be bound by theory, the increased amounts of mono-aromatic and thiophene aromatic may result in the discrepancy between the catalytic cracking properties observed in MAT testing and the determined analine point.

At pages 15-16, please replace the paragraph beginning at page 15, line 24, continuing to page 16, line 8 with the following:

VGOs obtained from heavy hydrocarbon feedstocks, produced as described herein, are characterized as having an analine point of about 110°F to about 170°F depending upon the feedstock. For example, using Athabaska bitumen as a feedstock, the VGO exhibits an analine point of from about 110° to about 135°F, VGO obtained from Athabaska resid exhibits an analine point of about 148°F, while the VGO obtained from Kerrobert heavy

crude is from about 119° to about 158°F. If the VGO is hydrotreated, for example Athabaskan bitumen VGO, using standard methods known in the art, for example, using a reactor at about 720°F, running at 1500psig, with a space velocity of 0.5, and a hydrogen rate of 3625 SCFB, the analine point increases from about 133° to about to about 158°. Similar hydrotreating of an Athabaska-VGO resid increase the analine point to about 170°F. With hydrotreating, the API increases, for example, from about 14.2 (for ATB-VGO) to about 22.4 (for Hydro-ATB-VGO), or from about 11.8 (for ATB-VGO resid) to about 20 (for Hydro-ATB-VGO resid), with a decrease in the sulfur level from about 3.7 wt% to about 0.27 wt% (for ATB-VGO and Hydro-ATB-VGO, respectively; see Example 6).

At page 20, please replace the paragraph at lines 1-20 with the following:

It is preferred that the reactor used with the process of the present invention is capable of producing high yields of liquid product for example at least greater than 60% vol, preferably the yield is greater than 70% vol, and more preferably the yield is greater than 80%, with minimal by-product production such as coke and gas. Without wishing to limit the scope of the invention in any manner, an example for the suitable conditions for a the pyrolytic treatment of feedstock, and the production of a liquid product is described in US 5,792,340, which is incorporated herein by reference. This process utilizes sand (silica sand) as the heat carrier, and a reactor temperature ranging from about 480° to about 620°C, loading ratios of heat carrier to feedstock from about 10:1 to about 200:1, and residence times from about 0.35 to about 0.7 sec. Preferably the reactor temperature ranges from about 500° to about 550°C. The preferred loading ratio is from about 15:1 to about 50:1, with a more preferred ratio from about 20:1 to about 30:1. Furthermore, it is to be understood that longer residence times within the reactor, for example up to about 5 sec, may be obtained if desired by introducing the feedstock within the reactor at a position towards the base of the reactor, by increasing the length of the reactor itself, by reducing the velocity of the heat carrier through the reactor (provided that there is sufficient velocity for the product vapour and heat carrier to exit the reactor), or a combination thereof. The preferred residence time is from about 0.5 to about 2 sec.

At page 28, please replace the paragraph at lines 21-23 with the following:

A6

From SimDist analysis, liquid products obtained following multi-stage processing of heavy oil can be characterized by comprising at least one of the following properties:

At page 29, please replace the paragraph at lines 17-18 with the following:

A7

The liquid product obtained from multi-stage processing of bitumen may be characterized as having at least one of the following properties:

At page 30, please replace the paragraph at lines 10-14 with the following:

A8

Collectively these results show that a substantial proportion of the components with low volatility in either of the feedstocks have been converted to components of higher volatility (light naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 34, please replace the paragraph at lines 9-18 with the following:

A9

Simulated distillation (SimDist) analysis of feedstock and liquid product obtained from several separate runs is present in Table 5. SimDist analysis followed the protocol outlined in ASTM D 5307-97, which reports the residue as anything with a boiling point higher than 538°C. Other methods for SimDist may also be used, for example HT 750 (NCUT; which includes boiling point distribution through to 750°C). These results indicate that over 50% of the components within the feedstock evolve at temperatures above 538°C. These are high molecular weight components with low volatility. Conversely, in the liquid product, the majority of the components, approx 62.1% of the product are more volatile and evolve below 538°C.

At page 35, please replace the Table 5 heading at lines 1-2 with the following:

A^{10} **Table 5: SimDist analysis of feedstock and liquid product after single stage processing (Reactor temp 538°C)**

At page 36, please replace the Table 6 heading at line 1 with the following:

A^{11} **Table 6: Stability of liquid products after single stage processing**

At pages 36-37, please replace the paragraph beginning at page 36, line 17, and continuing to page 37, line 3 with the following:

A^{12} These results indicates that undiluted bitumen may be processed according to the method of this invention to produce a liquid product with reduced viscosity from greater than 1300 cSt (@40°C) to about 25.6 - 200 cSt (@40°C (depending on the run conditions; see also Tables 8 and 9), with yields of over 75% to about 85%, and an improvement in the product API from 8.6 to about 12 - 13. Again, as per Example 1, the liquid product exhibits substantial upgrading of the feedstock. SimDist analysis, and other properties of the liquid product are presented in Table 8, and stability studies in Table 9.

At page 37, please replace the Table 8 heading at lines 5-6 with the following:

A^{13} **Table 8: Properties and SimDist analysis of feedstock and liquid product after single stage processing (Reactor temp. 545°C).**

At page 38, please replace the Table 9 heading at lines 1-2 with the following:

A^{14} **Table 9: Stability of liquid products after single stage processing (reactor temperature 525°C)**

At page 43, please replace the Table 12 heading at lines 1-2 with the following:

Table 12: Characterization of the liquid product obtained following Multi-Stage processing of Saskatchewan Heavy Oil and Bitumen

At page 43, please replace the paragraph at lines 5-10 with the following:

The liquid products produced from multi-stage processing of feedstock exhibit properties suitable for transport with greatly reduced viscosity down from 6343 cSt (@40°C) for heavy oil and 30380 cSt (@40°C) for bitumen. Similarly, the API increased from 11 (heavy oil) to from 15.9 to 18.2, and from 8.6 (bitumen) to 14.7. Furthermore, yields for heavy oil under these reaction conditions are from 59 to 68 % for heavy oil, and 82% for bitumen.

At pages 44-45, please replace the paragraph beginning at page 44, line 13, continuing to page 46, line 9 with the following:

SimDist results indicate that over 50% of the components within the feedstock evolve at temperatures above 538°C (vacuum resid fraction), while the liquid product is characterized as comprising approx 78 to 87% of the product that are more volatile and evolve below 538°C. The feedstock can be further characterized with approx. 0.1 % of its components evolving below 193°C (naphtha/kerosene fraction), v. approx. 1.3 to 4.8% for the liquid product. The kerosene and diesel fractions also demonstrates significant differences between the feedstock and liquid product with 1% of the feedstock fraction evolving between 193-232°C v. 2.8 to 5% for the liquid product, and with 8.7% (feedstock) and 18.9 to 23.1% (liquid product) evolving at this temperature range (232-327°C; diesel). Collectively these results show that a substantial proportion of the components with low volatility in the feedstock have been converted to components of higher volatility (light

naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 45, please replace Table 14 as follows:

Table 14: Properties and SimDist of liquid products prepared from Bitumen following "Two Stage" processing (reactor temp. 538°C; for feedstock properties see Tables 1, 8 and 9).

Fraction	Temp (°C)	R243
Density @ 15.6°C	-	0.9737
API	-	13.7
Viscosity @40°C	-	45.4
Light Naphtha	<71	0.3
Light/med Naphtha	71-100	0.4
Med Naphtha	100-166	3.6
Naphtha/Kerosene	166-193	1.9
Kerosene	193-232	4.4
Diesel	232-327	19.7
Light VGO	327-360	9.1
Heavy VGO	360-538	41.1
Vacuum Resid.	>538	19.5

At page 46, please replace the paragraph at lines 1-12 with the following:

Simulated distillation analysis demonstrates that over 50% of the components within the feedstock evolve at temperatures above 538°C (vacuum resid fraction) while 80.5% of the liquid product evolves below 538°C. The feedstock can be further characterized with approx. 0.1 % of its components evolving below 193°C (naphtha/kerosene fraction), v. 6.2% for the liquid product. The diesel fraction also demonstrates significant differences between the feedstock and liquid product with 8.7% (feedstock) and 19.7% (liquid product) evolving

at this temperature range (232-327°C). Collectively these results show that a substantial proportion of the components with low volatility in the feedstock have been converted to components of higher volatility (light naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 46, please replace the paragraph at lines 29-30 as follows:

For hydrotreating the Athabasca bitumen VGO, the reactor conditions were as follows:

At page 48, please replace the Table 16 heading at line 4 as follows:

Table 16: Microactivity Testing (MAT) results

At page 52, please replace Table 17C as follows:

Table 17C: Calculated Analine Point on a vol% basis, continued

	ATB-VGO (255) Vol % FF	Hydro-ATB-VGO (255) Vol % FF	ATB-VGO resid Vol % FF	Hydro ATB-VGO resid Vol % FF
Fresh Feed Rate:	68.6	68.6	68.6	68.6
Riser Outlet Temperature °F	971	971	971	971
Fresh Feed Temperature °F	503	503	503	503
Regenerator Temperature °F	1374	1238	1345*	1345*
Conversion	60.86	75.29	83.82	72.34
C2 and Lighter	6.13	3.36	4.80	4.13
H2S	1.42	0.12	1.55	0.04
H2	0.14	0.17	0.18	0.60
Methane	1.85	1.13	1.43	1.56
Ethylene	1.10	1.04	0.48	0.79
Ethane	1.63	0.89	1.17	1.14
Total C3	7.54	10.44	7.66	8.49

At page 54, please replace the paragraph at lines 3-11 with the following:

These results indicate that VGOs prepared from liquid products following rapid thermal processing as described herein (e.g., ATB-VGO, KHC-VGO and Hydro-ATB-VGO) are substantially different from VGOs obtained from similar feedstocks that have been only processed using conventional methods (e.g., distillation), for example ANS-VGO. Further analysis of the above VGOs obtained following rapid thermal processing indicates that they are characterized by having a unique hydrocarbon profile comprising about 38% mono-

10